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# "Testing of High-Performance Concrete using Recycled Aggregates"

Ms. Sakshi Harish Gaidhane[1], Ms. Ekta Gopichand Pandey[2], Ms. Pranali Shamrao Dhengale[3], Mr. AyushChintaman Khelkar[4], Mr. Harshad Amol Mule[5], Prof. Neha Khobragade[6]
[1, 2, 3, 4, 5, 6]*Department of Civil Engineering, Suryodaya College of Engineering and Technology, Nagpur2020-2019*

***Abstract:*** ***Tons of waste is produced in the world on every day basis which sometimes gets really hard to manage and. The waste from demolished structures is one of them. Recycling waste consume energy and produces pollution that can lead to many adverse effects on the environment and human life. The disposal of waste is also very dangerous for the environment. Using waste materials like waste aggregates, broken bricks, stones and other material in concrete can help in eliminating the waste and save the environment getting polluted. It is also very much economical and encourages green concrete industry. The literature study consists of testing of high-performance concrete using waste aggregates by replacing 100 % natural aggregates. Also, silica fume and plasticizer are used as admixture to obtain more effective results. The tests were carried out on 3, 7 and 21 days of curing. The results were tallied using graphs between comparison of compressive strength and tensile strength of natural and recycled aggregates. The cement and natural aggregates and sand was obtained from a local store in a nearby market. The recycled aggregates were obtained from a nearby demolished building. The quantities were taken in a proper proportion according to IS codes to avoid any defects while constructing the cubes and while curing and performing various tests.***

***Keywords: Recycled Aggregates, Natural Aggregates, Concrete Strength, High Performance Concrete, Properties of Concrete, Cost Effective***

## I. INTRODUCTION

Concrete is highly and most commonly used construction material world wide because of its high strength properties. Concrete contains a proper mix proportion of cement, aggregates (coarse and fine), sand and water. India's overall cement production capacity was nearly 545 million tons in FY20. Of total, 98% lay with the private sector and rest with public sector. The top 20 companies account for around 70% of the total cement production in India. Indian construction industry consumes approximately 400 million tons of concrete every year. But along with the rise of demand some side factors are also affecting the market, one of which includes increased production costs along with employee salaries and increase in prices. This project studies results to be very cost effective as the strength of natural and recycled aggregates are almost the same, but the costing of recycled aggregates is lesser than natural aggregates.

## II. MIX DESIGN OF MATERIALS

### *A. Materials*

Various materials are required in the composition of concrete like Concrete, Aggregate, Sand, Water andadmixtures. Each material has their individual characteristics, composition and properties which plays very important role in gaining the strength of the concrete.

1) *Cement:* Ordinary Portland cement of grade 53 is used in this project which is easily available in any nearby local market. The cement has alreadybeen tested for various proportions as per IS4031-1998 and specifications of IS 4031-1997. The below table shows the details of various properties of cement that has been used for this project.
2) *Aggregates:* Types of aggregates used in the projects are fine aggregates, coarse aggregates and recycled aggregates. All the aggregates are tested for their properties and is sieved through the required set of sieves to obtain the sieve analysis. The fine aggregates are obtained from the natural sand and crushed stone particles which is easily available in nearby area. It has been sieved through 4.75mm IS sieve and others were removed. The Coarse Aggregates were bought from the nearby local stone

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quarry. It was sieved according to the IS sieveand aggregates above 4.75mm were used. Recycled Aggregates were obtained from a demolished building. The material obtained from the demolished construction was tested in the concrete lab of our Civil Engineering department. Various tests were conducted on all the aggregates as per IS 383-1970.

3) *Silica:* Silica fume is also known as micro silica, which is anon-crystalline polymorph of silicon dioxide. It is a byproduct of the silicon and ferrosilicon alloy and consists of spherical particles with an average diameter of 150mm. The addition of silica fume in high performance concrete increases the strength of by 15%. Effect of silica fume decreases with the increase of cement content and decreases water-cement ratio. Hence the proper mix proportion is necessary.
4) *Super Plasticizer:* They are also known as high range water reducers. They are aura mix 400 obtained from fosroc chemicals. These are additives used in making high strength concrete. Plasticizers are chemical compounds that enable the production of concrete with approximately 15% less water content and provide extra content and durability to the concrete.

## III. LITERATURE REVIEW

A. *Utilization of recycled concrete aggregates for High Performance alkali activated concrete -Towards a sustainable building solution – CL Hwang, MD Yehualow and DH Vo (2019).*

The demand of concrete in construction industry results into the need of this project. The main purpose was to prepare environment friendly and highly sustainable concrete. Both natural and fine aggregates were replaced in specific proportion with recycled concrete aggregates which was obtained from demolishing waste. Cement powder was replaced by pozzolanic industrial wastes which made highly alkali activated concrete. The results showed that the alkali activated concretehas effective properties and better practice of sustainable concrete construction was achieved.

B. *High Performance Concrete using recycled aggregate, Micro silica and Synthetic macro fiber - Ajibola Tijani (2015).*

This project was initiated for a better, low maintenance and corrosion free prestressed concrete sleepers for rail transportation network in UK. The conventional ballasted rail track system incorporating steel tendon in prestressed concrete sleepers were predominantly used throughout the whole railway network in UK. In varying proportion (0%, 25%, 50%, 75%, 100%), the replacement was done using recycled aggregates, micro silica and synthetic macro fiber. Total 621 samples were tested for their workability, durability, density measurement, modulus of elasticity, compressive strength, flexural strength and tensile splitting strength test in different phases.The results were very positive and improving and showed that enhanced strength could beassociated with densifying quality and pozzolanic action of micro silica.

C. *Influence of field Recycled Coarse Aggregates on properties of Concrete – Chakradhar Rao and S.K. Bhattacharya (2011).*

In this experiment a new term was introduced named “coarse aggregate replacement ratio (CRR) which is nothing but the ratio of weight of coarse aggregate to total weight of coarse aggregate in a concrete mix. To analyze the behavior of concrete, CRR of 0, 0.25, 0.50 and 1.0 were obtained. Tests like compressive and indirect tensile strength test, modulus of elasticity, water absorption, volume of voids, density of hardened concrete and depth of chloride penetration are studied. Results showed that the strength of concrete cured in 7 days was better than that of the concrete cured in 28 days for all CRR.

D. *Ecological High-Performance Concrete – Wojciech Kubissa (2017).*

The authors had used two different waste materials which are recycled concrete aggregates and fly ash, to obtain high performance concrete (HPC). Different types of cements and supplementary cementing materials were mixed with RAC. All the specimens were tested for their physical properties and strength properties in the curingof 28 days and 90 days. Results were positive and effective.

E. *Long Term Mechanical and Durability properties of Recycled Aggregates prepared with incorporation of fly ash – Shi-Cong Kou and Chi-Sun Poon (2013).*

Long term study on the mechanical and durability properties of concrete prepared replacing aggregates with recycled aggregates by 25%, 35% and 55%. Fly ash was used as a binding agent. Results were observed after 10 yrs. that the compressive strength and modulus of elasticity were lower with 100% replacement than that of controlled concrete. Fly ash improved the resistance to chloride ion penetration but also increased the depth ofconcrete.

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## IV. RESULTS

The concrete blocks were made using natural aggregates and also by replacing natural aggregates to the recycled aggregates. 3 specimens were observed for 3 days, 7 days and 21 days for both type of concrete (with natural and with recycled aggregates). Comparison was done between the concretes on basis of their compressive strength andtensile strength.

The results of the Compressive strength test areshown in the table below.

Table 4.1 Compressive Strength ofConcrete (N/mm2) using Natural Aggregates

| Days | Specimen 1 | Specimen 2 | Specimen 3 | Average |
|---|---|---|---|---|
| 3 days | 34.08 | 35.28 | 40.15 | 36.50 |
| 7 days | 63.02 | 69.98 | 70.03 | 67.67 |
| 21 days | 75.34 | 78.21 | 81.16 | 78.23 |

Table 4.2 Compressive Strength of Concrete usingRecycled Aggregates

| Days | Specimen 1 | Specimen 2 | Specimen 3 | Average |
|---|---|---|---|---|
| 3 days | 30.31 | 34.02 | 32.01 | 32.17 |
| 7 days | 64.08 | 66.37 | 65.28 | 65.48 |
| 21 days | 84.0 | 89.71 | 91.13 | 88.28 |

Table 4.3 Graphical representation of Comparisonbetween Compressive Strength of Concrete using Natural Aggregates and Recycled Aggregates.

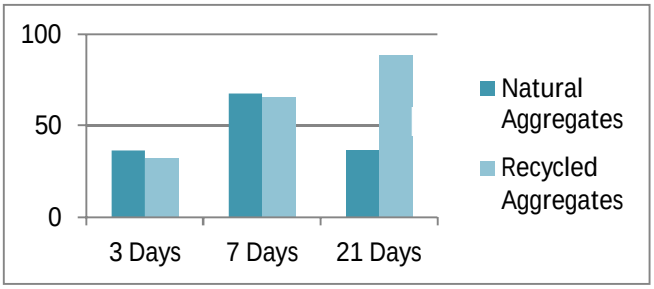


Table 4.4 Tensile Strength (N/mm2) for Natural Aggregates and Recycled Aggregates after 21 daysof curing.

| Concrete Mix Type | Specimen1 | Specimen2 | Average |
|---|---|---|---|
| Natural Aggregate | 5.27 | 4.99 | 5.13 |
| Recycled Aggregate | 5.32 | 5.71 | 5.51 |

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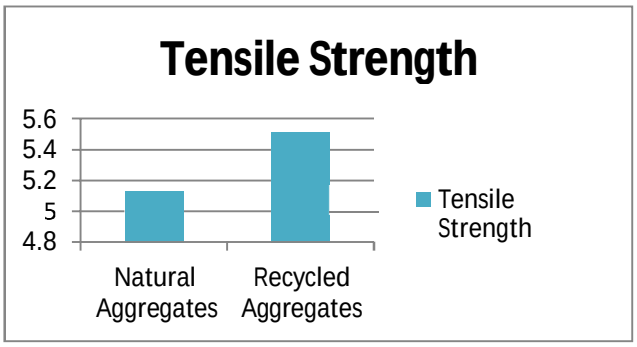
Table 4.5 Graphical representation of Comparison between Tensile Strength of Concrete using NaturalAggregates and Recycled Aggregates




## V. CONCLUSIONS

The results show that the replacement of Recycled aggregates in place of Natural aggregates in High Performance Concrete is an effective experiment. The High-Performance Concrete using Recycled Aggregates had shown higher Strength than concrete with natural aggregates. The HPC with recycled aggregates havealso shown greater water absorption than naturalaggregate. The HPC using recycled aggregates is also cost effective as the natural aggregates are quite expensive whereas you can get recycled aggregates from any local market at very cheap price or even you can obtain it from any demolition site. This experiment also proven that this method is so much eco-friendly as we are using waste material only. The addition of admixtures like Silica fume and super plasticizer helps increasing the resistance and properties of concrete using recycled aggregates.

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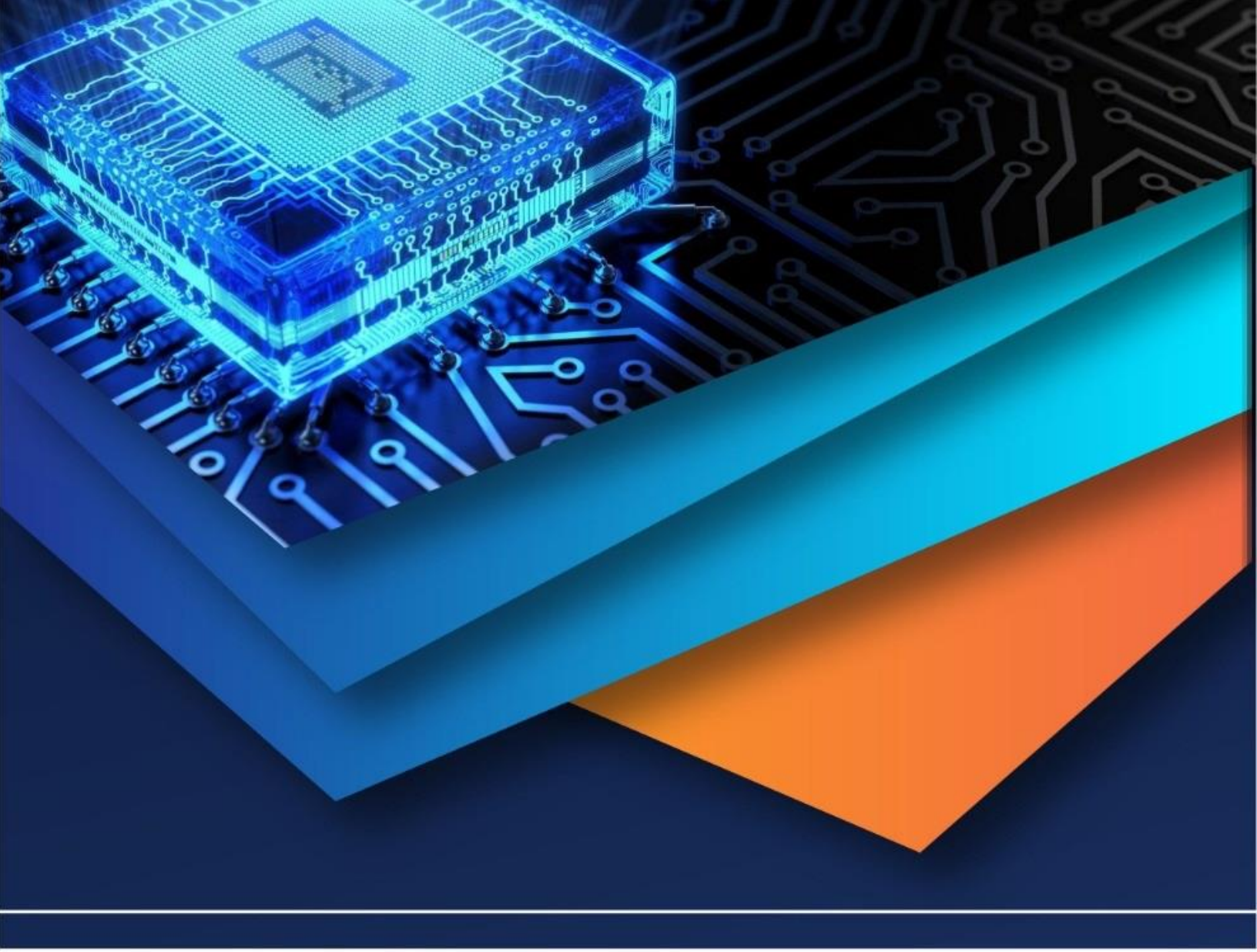

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